

**A GIS-Based Modal Model of Automobile
Exhaust Emissions**

FINAL REPORT

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ABSTRACT

Suburban sprawl, population growth, and auto-dependency have, along with other factors, been linked to air pollution problems in U.S metropolitan areas. Addressing these problems becomes difficult when trying to accommodate the needs of a *growing* population and economy while simultaneously *lowering* or maintaining levels of ambient pollutants. Growing urban areas must, therefore, continually develop creative strategies to curb increased pollutant production.

This report presents progress towards the development of a computer tool called MEASURE, the Mobile Emission Assessment System for Urban and Regional Evaluation. The tool works towards a goal of providing researchers and planners with a means for assessing new mobile emission mitigation strategies. The model is based in a geographic information system (GIS) and uses modal emission rates, varying emissions according to vehicle technologies and modal operation (acceleration, deceleration, cruise, and idle). Estimates of spatially resolved fleet composition and activity are combined with situation-specific emission rates to predict engine start and running exhaust emissions. The estimates are provided at user-defined spatial scales. A demonstration of model operation is provided using a 100 square kilometer study area located in Atlanta, Georgia. Future mobile emissions modeling research needs are developed from an analysis of the sources of model error.

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GLOSSARY AND ACRONYMS

AQL – Georgia Tech’s Air Quality Laboratory.

ARC - The Atlanta Regional Commission, the MPO for Atlanta, Georgia.

ARC/INFO - UNIX Based GIS Software by Environmental Systems Research Institute.

CBD – Atlanta’s Central Business District.

Conflation - The process of transferring textual information from one linear data representation to another.

Engine start - Term referring to the emission rate phenomenon occurring during the first few minutes of a vehicle’s operation.

Enrichment - Term referring to the emission rate phenomenon occurring during high power demand driving.

FTP - Federal Test Procedure, the emission test cycle from which the MOBILE5a emission rates were derived.

Geocoding - The process of establishing locational parameters (coordinates) from textual data.

GIS - Geographic Information System, computer hardware and software used for storing, displaying, analyzing, and modeling spatial information.

GPS - Global Positioning System, a device used to determine one’s position on the earth’s surface by triangulating distances from satellites.

HC – Hydrocarbons.

High emitters - Term applied to a small portion of the fleet that produces higher emission rates, usually the result of malfunctioning equipment.

Hot-stabilized - Term referring to the ‘stable’ emission rates characteristic of vehicles operating with active emission control equipment, usually occurring after a vehicle has warmed sufficiently.

LOS – Level of service is used to characterize operational conditions within a traffic stream and their perception by motorists and passengers.

Makefile - A text script used to manage multiple programs and files.

MEASURE - Mobile Emission Assessment System for Urban and Regional Evaluation, the model developed by the research reported here.

MOBILE5a - The active mandated emission rate model developed by the USEPA.

Modal emissions - Emissions that have been separated by specific operating conditions that result in distinct changes in emission rate behavior.

MPO – Metropolitan Planning Organization.

NAAQS - National Ambient Air Quality Standards, health-based air quality standards that cities must not exceed.

Normal emitters - Term applied to vehicles with low to moderate emission rates due to normal operation of emission control equipment.

NO_X – Nitrogen oxides.

Photochemical models - Computer models used to predict ambient air quality.

Pollutants of concern - Carbon monoxide, hydrocarbons, and oxides of nitrogen.

Ozone - Pollutant caused by the complex mixing process of NO_X and HC in the presence of sunlight.

Raster - Cell-based spatial data structure.

Running exhaust - Term applied to non-start exhaust pipe emissions that occur while a vehicle is in operation.

SCF - Speed Correction Factor, the technique found in MOBILE5a for adjusting emission rates based on the average speed of a vehicle, or sets of vehicles.

SOV – Single occupancy vehicle.

Sub-fleet - Term applied to any group of vehicles smaller than a regional operating fleet.

TAZ – The TAZ represents a spatial unit for aggregating socioeconomic data and resulting trip generation estimates.

Technology group - Term applied to categories of vehicles with similar characteristics resulting in similar emission rates.

TIN – Triangulated Irregular Network.

TMIP - Travel Model Improvement Program, USDOT plan to improve the standard travel demand forecasting modeling capabilities used by cities.

TRANPLAN - Travel demand forecasting software produced by the Urban Analysis Group.

TRANSIMS – Transportation Analysis and Simulation System.

Travel demand-forecasting models - Models that follow the standard four-step modeling strategy to predict travel behavior based on socioeconomic and infrastructure data.

Unix – Unix is an operating system originally developed in the 1960's and 1970's by scientists at the University of California at Berkeley and at AT&T Bell Laboratories and was designed to be used for running scientific and engineering applications on large processors.

USDOT – United States Department of Transportation.

USEPA – United States Environmental Protection Agency.

UTPS – Urban Transportation Planning System, a travel demand forecasting model, developed in the 1960s.

Vector - Topologic spatial data structure (points, lines, polygons).

VIN - Vehicle Identification Number, a code number revealing many vehicle characteristics and found on most vehicles.